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QUANTITATIVE DATA ON THE ALKALOID CONTENTS OF PAPAVER SOMNIFERUM AND PAPAVER BRACTEATUM CULTIVATED IN KUOPIO, FINLAND IN 1979 AND 1980

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INTRODUCTION

In the previous report on our work (UN document ST/SOA/SER.J/39) concerning the alkaloid content of different samples of Papaver somniferum L. grown in Finland, it appeared that the intensive growth season in northern latitudes produces in a short period of time plants containing considerable amounts of the alkaloids studied, i.e. morphine, codeine, thebaine, noscapine and papaverine. In 1979 when the weather conditions, especially in eastern Finland, were excellent, certain plants such as UNL 136 and 364 produced even higher amounts of alkaloids than in the countries of origin. Likewise, studies on first year leaves of P. bracteatum Lindl. revealed that this species produced thebaine (UNL 581 also produced alpinigenine) as the major alkaloid.

The purpose of the present study was to recultivate UNL 101, 110, 119, 136, 275 and 364 seeds of P. somniferum in 1980 under the same environmental conditions as in Kuopio in 1979, and to find out whether the alkaloid contents are constant or not in different years. In addition, the alkaloid contents of second year leaves and capsules of P. bracteatum grown in the same place were also investigated.

EXPERIMENTAL

P. somniferum seeds (UNL 101, 110, 119, 136, 275 and 364) were cultivated from 20 May in the Botanical Garden of the University of Kuopio (400 km north of Helsinki) in the same way as in 1979. These seeds were supplied through the courtesy of the United Nations Narcotics Laboratory.

The growth and behaviour of the plants were similar to those of the same seeds cultivated in 1979. The summers of 1979 and 1980 were both warm and only slightly rainy in eastern Finland, so there were no major

climatic differences between these years. In both years, flowering of the P. somniferum plants started during the end of July although immature, fully grown capsules were formed in the first half of August. However, the flowering time in 1980 was more irregular than in 1979. For example, some plants were still flowering in October. Distinct differences in the size of the plants and capsules even from the same seeds were observed. The cause for this unusual behaviour is unknown.

As pointed out in our earlier report (UN document ST/SOA/SER.J/39) less than 50 % of the P. bracteatum Lindl. plants survived the hard winter of 1979-80 (minimum temperature -36°C) and the remaining plants died during the summer of 1980. Therefore, only 10 plants were flowering at the end of June and immature capsules were collected on 5 July.

Sampling and analysis

The sampling and HPLC analysis of the materials were carried out in the same way as described in our earlier report. However, only total plants of P. somniferum were analyzed this time.

Results

The morphine, codeine, thebaine, noscapine and papaverine contents of P. somniferum grown in Kuopio in 1980 are presented in Table 1. The concentrations are expressed as percentages of the dry weight of the entire plants (including the roots).

The thebaine and alpinigenine contents of P. bracteatum samples collected in 1979 and 1980 in Kuopio are shown in Table 2.

DISCUSSION

Alkaloids of P. somniferum

Variations in alkaloidal contents

In agreement with the morphological variations, considerable variations in the total and individual alkaloid contents could be observed in the materials of 1979 and 1980. The maximum percentages of most alkaloids were found during the first two weeks of August. Concerning the morphine content, it was found that UNL 364 was rich in morphine both in 1979 and 1980, whereas UNL 110, 136 and 275 were rich in morphine in 1979 but rather poor in 1980. UNL 101 and 119 were poor in morphine in both years. The codeine content of all plants was rather small and regular in 1979, but somewhat higher in 1980, although more irregular values were observed. In 1980, especially relatively high concentrations of this alkaloid were observed in UNL 136, 275, 364 and (less distinct) in 119. In both years lower codeine content values were observed for 101 and 110.

UNL 101 and 110 yielded low concentrations of thebaine both in 1979 and 1980, whereas higher but more irregular values were obtained for 136, 275 and 364. The classification of UNL 119 is more difficult based on the data obtained. The noscapine content was rather irregular. It was generally low both in 1979 and 1980 for UNL 101, 110 and 119 and somewhat higher for UNL 136, 275 and 364. Concerning the papaverine content, UNL 136 was rich in both years, while the rest of the UNL samples were poor both in 1979 and 1980.

There were distinct differences in the contents of the alkaloids studied due to seasonal variation. To give really clear profiles of the alkaloidal contents the sampling should be done at the same optimal developmental stage. In eastern Finland the optimum condidtions seem to be during the first two weeks of August.

Chemoprovarieties

Recent large scale selection studies on different varieties of P. somniferum have revealed that the alkaloid content is distinctly variable in this species (Nyman and Hall 1974, 1976, Nyman and Hansson 1978, Nyman 1978, 1980, a, b). Based on the nomenclature system suggested by Tétényi and Végújfalvi 1965 and the current knowledge of the biosynthetic pathways, Nyman and Hansson 1978 classified their materials in the following way (the alkaloid contents were calculated as percentages on dry, ripe capsules);

1. Chemoconvariety: morphinane (ccv. Morph.)
   A. Chemoprovariety: morphine (cpv. Morph: Mo).
      Only morphinane alkaloids are present in contents <0.03 per cent and morphine is the major alkaloid
   B. Chemoprovariety: thebaine (cpv. Morph: The).
      Only morphinane alkaloids are present in contents <0.03 per cent and thebaine is the major alkaloid
   C. Chemoprovariety: low alkaloid (cpv. Morph: LA).
      Only morphinane alkaloids are present in contents <0.03 per cent and morphine is the major alkaloid

2. Chemoconvariety: isoquinoline (ccv. iQ)
   A. Chemoprovariety: isoquinoline (cpv. iQ)
      Morphinane, benzyl- and phthalideisoquinoline alkaloids are present in contents >0.03 per cent

   B. Chemoprovariety: benzylisoquinoline (cpv. iQ:Benzyl).
      Morphinane and benzylisoquinoline alkaloids are present in contents >0.03 per cent.
   C. Chemoprovariety: phthalideisoquinoline (cpv. iQ:Phthalide).
      Morphinane and phthalideisoquinoline alkaloids are present in contents >0.03 per cent.

Our materials were cultivated under uniform conditions in the Botanical Garden of the University of Kuopio in both years investigated. Therefore all differences in contents of alkaloids must be hereditary, and three different chemoprovarieties can be identified if the material is classified according to the scheme above. As our investigations were made on total dry plants and not on dry capsules, the results are not directly comparable with those of Nyman and Hansson 1978. If this and other methodic differences are neglected, UNL 101, 110 and 119 can be classified as belonging to cpv. Morph: Mo, UNL 136 to cpv. iQ:'Q, and UNL 275 and 364 may be regarded as belonging to cpv. Morph: Phthalide

P. bracteatum

As expected thebaine is always the main alkaloid. However, UNL 581 yielded in addition to thebaine, considerable amounts of alpinigenine. No clear differences between first and second year leaves were found.

Table 1: Alkaloid content of *P. somniferum* - samples grown in Kuopio, Finland in 1980.

Concentration of the alkaloids (% of dry weight)

SAMPLE	DATE	MORPHINE	CODEINE	THEBAINE	NOSCAPINE	PAPAVERINE
UNL 101	28.7.80	0.043	0.0195	0.0011	0.0020	<0.0005
	4.8.80	0.050	0.0193	0.0020	0.0025	<0.0005
	13.8.80	0.045	0.0108	0.0012	0.0015	<0.0005
	26.8.80	0.043	0.0223	0.0016	0.0025	<0.0005
UNL 110	28.7.80	0.158	0.0260	0.0069	0.0397	0.0071
	4.8.80	0.060	0.0041	0.0010	0.0026	<0.0005
	13.8.80	0.042	0.0050	<0.0005	0.0019	<0.0005
	26.8.80	0.091	0.0054	<0.0005	0.0247	<0.0005
UNL 119	28.7.80	0.028	0.0013	0.0009	<0.0005	<0.0005
	4.8.80	0.093	0.0162	0.0048	<0.0005	<0.0005
	13.8.80	0.060	0.0081	0.0010	<0.0005	<0.0005
	26.8.80	0.029	0.0524	0.0219	0.0010	<0.0005
UNL 136	28.7.80	0.051	0.0664	0.0047	0.0279	0.1090
	4.8.80	0.096	0.0313	0.0098	0.0481	0.0610
	13.8.80	0.057	0.0488	0.0034	0.0352	0.0075
	26.8.80	0.096	0.0782	0.0107	0.0239	0.0358

SAMPLE	DATE	MORPHINE	CODEINE	THEBAINE	NOSCAPINE	PAPAVERINE
UNL 275	28.7.80	0.107	0.0426	0.0091	0.0320	<0.0005
	4.8.80	0.140	0.0200	0.0010	0.0640	0.0023
	13.8.80	0.167	0.0792	0.0065	0.0072	0.0055
	26.8.80	0.078	0.0530	0.0094	0.0195	0.0122
UNL 364	28.7.80	0.339	0.0478	0.0072	0.0182	<0.0005
	4.8.80	0.0359	0.0600	0.0151	0.0520	<0.0005
	13.8.80	0.0280	0.0277	0.0054	0.0540	<0.0005
	26.8.80	0.360	0.0250	0.0021	0.0577	<0.0005

Table 2. Alkaloid contents of P. bracteatum samples grown in Kuopio

Samples of first year leaves 1979

Content of alkaloids, % of dry weight

Sample	Date	Thebaine	Alpinigenine
UNL 8	21.7.	0.223	<0.005
	26.8.	0.065	<0.005
UNL 11	26.8.	0.113	<0.005
UNL 441	21.7.	0.139	<0.005
	26.8.	0.058	<0.005
UNL 581	21.7.	0.080	0.072
	26.8.	0.138	0.082
UNL 594	26.8.	0.210	<0.005

Samples of second year leaves and capsules 1980

Content of alkaloids, % of dry weight

Sample	Date	Thebaine	Alpinigenine
UNL 11 leaves	5.7.	0.12	<0.005
UNL 441 leaves	5.7.	0.10	<0.005
UNL 581 leaves	5.7.	0.15	<0.004
caps.	5.7.	0.24	0.09
UNL 594 leaves	5.7.	0.19	<0.005
caps.	5.7.	0.24	<0.005

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